

BREEDING OF ANOPHELINE MOSQUITOES AMONG AQUATIC VEGETATION OF GATUN LAKE, ACCOMPANIED BY PERIODIC LONG FLIGHTS OF *A. ALBIMANUS* WIED.*

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It was believed by early workers in mosquito control that the flight-range of all *Anopheles* mosquitoes was extremely limited, nearly as limited indeed as that of the house-breeding yellow fever mosquito, *Aedes aegypti*, or of the night-biting domestic pest, *Culex fatigans*. Evidence is accumulating, however, which indicates quite the contrary; that at certain places and times, and under certain conditions, certain species of *Anopheles* fly over relatively enormous distances.

For many years the field workers of the division of sanitation of the health department of the Panama Canal have noted flights of *Anopheles albimanus* Wied., our most effective carrier of malaria, which must have come over distances which once would have been considered preposterous to suggest as possible. One should, of course, be extremely careful in drawing conclusions as to the source of any particular mosquito or flight, but I believe that our many years of observation in this field justify our conclusions regarding these flights.

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The Isthmian year is divided into two major seasons, the dry season of approximately four months' duration, January to April, inclusive, and the wet season of the remaining eight months. The dry season is characterized by strong, persistent north winds, the trade-winds, and much sunshine. Deciduous trees shed their leaves, the grasses die, and the ground becomes baked and fissured. An occasional shower may occur, but flood conditions do not result, for the baked earth absorbs the rainfall quickly. As the dry season draws to a close, and the wet season is about to begin, there is an intermediate period of some days, or even of a few weeks, during which the winds subside, the air grows more oppressively humid, the sky is overcast with clouds, and the temperature rises a few degrees, certainly the most uncomfortable season of the Isthmian year. There may be an occasional shower, but still the parched earth greedily drinks it in and no pools of standing water are created. Later, as the real wet season begins, there are copious, almost daily showers, but even these fail to establish permanent pools in sunlit areas, such as are preferred by the *albimanus* species of *Anopheles*, until the ground has become thoroughly saturated, usually a matter of several weeks more.

It is during these warm, humid, almost windless days of the intermediate period, before the real wet season begins, that the flights of *A. albimanus* occur. Practically simultaneously over the whole Canal Zone they are noted. Throughout the year the sanitary inspectors make weekly night catches of mosquitoes (6:00 to 8:30 p. m.) within the sanitized areas. During the height of the dry season the catch falls to practically nothing and the number of catchers and stations is reduced, but with the approach of the wet season they are again increased so as to note the first appearance of the flights. During the time of their maximum activity even daily early-morning catches are

made at selected stations. For the fifteen years that the writer has been associated with the work these catches have been made fairly systematically, and every year it has been noted that the onset of the rains has been preceded by the appearance of flights of *A. albimanus* into the sanitized areas. Naturally, the constantly recurring question in the minds of all of us has been *what is the origin of these flights?*

Perhaps in no other jungle-covered, tropical country of equal extent is the terrain so thoroughly explored and known as it is in the Canal Zone and its vicinity. In the first place, the sanitary inspectors and their forces are men of long experience here, some of them having had more than twenty-five years of continuous service with the health department. Moreover, the Corps of Engineers of the Panama Canal Department of the U. S. Army has for years been making a painstaking survey of the entire region, and excellent topographic maps, lithographed in colors and on a large scale, are available for use by the health department. Airplane trips over doubtful areas are made by the sanitary inspectors in search for collections of water, and large scale photographs ("mosaics") are made for us by the Army Air Service. The "gold" (white American) supervisory personnel are men of rugged physique who take a keen delight and interest in the jungle life and in their work. Exploration of distant or isolated areas is looked upon as a delightful adventure rather than a task, and there is hardly a spot where water could exist that is not visited many times, be it ever so difficult of access. Thus it would seem impossible that there could exist, at the time the flights occur, an unknown breeding place of extent large enough to furnish the great numbers of mosquitoes that take part in them.

There is only one such breeding place known here, Gatun Lake, that great, artificial body of water 165 square miles in extent that was

constructed as a part of the lock-system canal and completed and filled in 1913.

To the uninformed it usually appears that water alone is needful for the propagation of mosquito larvae, but that is as far from the truth as to believe that man can live on the bare earth alone, that the great deserts could support human life. Even as much as man, the mosquito larva requires food, certain conditions as to light, air and temperature, shelter from enemies, and so on, and each species of mosquito makes demands that are more or less peculiar to itself. Thus the *albimanus* larva usually requires such conditions as exist only in fairly clean, quiet bodies of water exposed to the sunlight, rich in microscopic life as a food supply, and provided with a type of vegetation or floating debris that gives to the surface feeding larva protection from its predatory enemies, such as other insects and fish. It also shows a decided preference for human society and, under conditions apparently identical otherwise, it will breed in demonstrably far greater numbers in the vicinity of an inhabited house.

Gatun Lake did not at first present such favorable conditions. The flora and fauna natural to such a body of water were lacking, and developed only as nature adjusted herself to the tremendous change that had been imposed upon the region. In addition, and this is important, the entire Canal Zone was depopulated of all human inhabitants except Government employes, and these latter were concentrated mainly in a few towns and villages along the Panama Railroad. The lake itself, save for the channel for the passage of ships, at first presented a melancholy appearance of inundated jungle, a dreary expanse of dead and dying trees, shrubs and vines. As these were eaten down by termites, or rotted away to the water line, the aspect slowly changed and a new aquatic vegetation began to take possession; and even this latter is showing profound changes as time goes on.

From the beginning, the floating debris became lodging places for grasses and other aquatic plants; thus thousands of floating islands were formed, and still exist, slowly increasing in size. Two species of water-hyacinth (*Piaropus crassipes* and *P. azureus*) and a floating aroid, waterlettuce (*Pistia stratiotes*), took possession of every shallow inlet. The hyacinth became a serious inconvenience to navigation and the Canal has been obliged to spend enormous sums for its control by means of arsenic sprays. After flourishing for some years the waterlettuce, spontaneously and for some unknown reason, has almost disappeared from Isthmian waters, even in remote ponds where it was not exposed to the poison treatment used on the hyacinths. These plants and the floating islands are of importance because they, too, support a mosquito fauna peculiar to themselves.

The close association of *A. bachmanni* Petrocchi with *Pistia* is worth noting. Fortunately, there remains in one arm of the lake, the Paja River inlet, a fairly large number of the plants of *Pistia*. Among these plants *A. bachmanni* makes its larval creche, and they may usually be found there in large numbers to the exclusion of any other species. In other breeding places, such as are about to be described, *A. bachmanni* larvae are sometimes taken, one or two at most among hundreds of others, but such appearances of this species away from *Pistia* are exceedingly rare. It is of no importance here as a malaria carrier.

In recent years the health department has noted in the lake a great increase in two aquatic plants that promise to be of the utmost importance in the problem of malaria control. These are a species of bladderwort (*Utricularia mixta*) and several species of *Chara* (brittlewort or stonewort). These plants are usually entirely submersed, *Chara* being rooted in the bottom mud, and *Utricularia* floating unattached except

when entangled with other vegetation. Both plants, under certain conditions, furnish apparently optimum conditions for the nurture of the species of *Anopheles* that require sunlit waters, especially of several of the white-hind-footed *Nyssorhynchus* group.

Chara first attracted attention in our lake waters in 1919, although it had probably existed in the region long before the construction of Gatun Lake. In 1922, notice was taken of it in the Annual Report of the health department and a photograph was reproduced in that report showing its appearance in the Rio Grande inlet of Miraflores Lake. It has now spread enormously in Gatun Lake, especially in the shallower inlets and along shelving banks. It may also exist to an unknown extent in some of the deeper waters, as Robinson (1906) states that it has been found growing in water up to 12 meters in depth. He states that there are 50 species known in North America, of which 17 occur in Mexico and Central America and 8 in the West Indies. The study of the Characeae and the determination of genera and species are most difficult. *Chara* is closely related to the algae and probably there are other related and somewhat similar plants here. Isthmian workers commonly refer to it as "moss."

The aquatic bladderwort (*Utricularia mixta*) is a flowering plant which has no real roots, but floats freely in the water unless accidentally anchored or entangled. In the flowering season it can be recognized by the tiny yellow flowers rising on slender stems a few inches above the surface of the water. The leaves spread beneath the surface in large, graceful, feathery patterns. Attached to the slender leaflets are the small "bladders" (whence comes its name) which serve as traps for the little animal forms that swarm in the tropical waters. These traps are too small to entrap any but a very young mosquito larva, but the surface-feeding-and-floating habits of the larvae of *Anopheles* en-

able them to avoid contact with the submerged traps and thus remain uncaptured.

Many thousands of acres of lake are occupied by these two plants. *Chara* is in practically every shallow part, but bladderwort, probably because it is free-floating and is carried in the direction of the prevailing winds, is found growing extensively only in the southwestern part of Gatun Lake; it appears to be almost completely absent in apparently similar inlets in the northeastern part. Neither *Chara* nor bladderwort extend their needle-like foliage above the surface of the water, but stop just short of the surface. However, as the dry season advances, the lowered waters of the lake bring the tops of these plants (including entangled bladderwort) to the surface, and as the water falls an increasing amount of the lake surface is covered with sheets of the matted top leaves. The maximum permitted elevation of the lake is at 87.5 feet above sea level, which elevation is reached at the end of the wet season. By the end of the ensuing dry season the lake may have fallen more than six feet (below 81.5 feet), and at this latter stage literally hundreds or even thousands of acres of water surface are covered with scattered carpet-like mats of vegetation, below which the living plants still flourish.

As may be expected, these mats are rich in microscopic algal and animal life, and therefore are an ideal source of food for mosquito larvae. The wet, almost gelatinous, surfaces also furnish excellent protection from top-feeding minnows and predatory insects. Thus there are, increasing in size throughout the dry season, stupendous breeding areas in which are found larvae of *Anopheles* in incalculable numbers. Even the most experienced investigators are astounded at the great numbers of larvae at times found in these places and at their extent. The longer the dry season lasts the lower the lake level falls, the more and greater the patches of *Chara* and bladderwort that appear at the surface, and,

consequently, the greater and more prolonged is the production of anopheline mosquitoes. This was especially marked this year when the lake equalled the lowest recorded level early in May and has since remained continuously at record low levels as compared with corresponding days of previous years.

An interesting phenomenon is that in the southwestern part of the lake, where bladderwort flourishes, *A. albitarsis* Lynch Arribálzaga is the dominant species, frequently outnumbering *albimanus* by more than twenty to one, and accompanied by a very occasional *A. bachmanni* or *A. strodei*. In other parts of the lake, where bladderwort is absent, only *A. albimanus* is found. One is deeply impressed when he sits in a dugout *cayuco* in the midst of an undulating surface patch of the matted tops of *Chara*, extending in an unbroken brown sheet as far as the eye can see, and, with a five by nine inch bread loaf pan, dips up more than a hundred *Anopheles* larvae of various stages and pupae at a single sweep over less than a square foot of surface. What must be the total daily emergence of mosquitoes over the whole lake at such times! If only one out of many thousands is able to reach the distant sanitated settlements this relatively small proportion is still large enough to account for the influx of adults that has been observed.

It is also interesting to note that apparently only *A. albimanus* undertakes this long journey. *A. albitarsis*, although breeding in enormously greater numbers throughout the southwestern part of the lake, is never taken on the wing or in houses or in the act of biting, even in the immediate vicinity of the most prolific breeding places. It seems to ignore man entirely as a source of blood. On the other hand, *A. albimanus*, as has already been stated, shows a marked preference for mankind, and even gives evidence of becoming somewhat domesticated, or at least of preferring to breed in the prox-

imity of human habitations. Probably its need for sunlit waters and, therefore, for cleared land has developed this preference, which is now apparent here both on land and in large expanses of water.

It is these characteristics of *albimanus* that make the recent repopulation of the Canal Zone and the lake area by agricultural settlers (mostly negro West Indians) of the greatest importance in the problem of malaria control. It is probable the invasion of the Zone towns by *Anopheles* from the distant lake areas (twelve miles and more from the Pacific side towns) is not accomplished by one direct flight from the breeding places. It seems more logical to assume that it takes place by a series of flights, perhaps in nightly stages, and that many of these mosquitoes have made their first, or even successive, stopping places at the cabin homes of settlers infected with malaria.

For certainly these *albimanus* are infected. Within a month's time following the beginning of the flights the Zone malaria rate has risen sharply. Simultaneously every part of the Isthmus suffers, Atlantic side as well as Pacific. Not that the rate is alarmingly high as compared with other tropical countries of similar climate, or with the earlier construction period of the Isthmus, but as compared with the present usual yearly rates the increase is marked.

As the wet season advances, the lake begins to rise once more and there is a gradual diminution in the amount of *Chara* and bladderwort exposed at the surface, although there is never a time when it is all submersed. Necessarily the amount of mosquito breeding decreases, too, as the favoring vegetation is submersed, and perhaps also the prolonged heavy rains destroy many adults and larvae. At any rate, the peak of the flights is soon passed, and thereafter, at the proper interval, the malaria rate also declines to its normal (that, of course, fluctuating) wet season rate.

The question of the control of these flights and the subsequent malaria incidence has for years given the health department grave concern. Frequent trips are made by launches to the various parts of the lake to determine the extent and the location of the breeding. Microscopes are taken along as a part of the equipment so that identifications may be made on the spot, and thousands of larvae are brought to the laboratory to breed out. But no easy solution of the problem as a whole has presented itself.

In the Stilson Pond inlet of Gatun Lake, from which the town of Gatun takes its water supply, the municipal engineer's forces wage unremitting warfare against the *Chara* by dragging it out into small boats and stranding it high on the banks. A number of men are engaged in this task almost the year round in order to obviate the necessity to use oil or other larvicides on the water supply. In the small group of lakes contributing to the Miraflores Locks the health department maintains a motor boat and several row-boats, in which latter are mounted oil tanks with hand pumps that cover the shore line and the patches of *Chara* twice monthly with a film of oil. The results here are excellent. But to attempt similar methods of control over the whole of Gatun Lake, with its 165 square miles of area and more than 1,000 miles of deeply indented shore line, would cost what is at present considered a prohibitive sum. Yet in the application of oil seems to lie the best solution of the problem should it ever become necessary to undertake the control of these areas.

Even airplane dusting with Paris green does not at this time seem feasible within permissible economic limits, nor would it be as effective on the whole as the oil spray. While there are in some places, notably in the Rio Gatun-Rio Agua Sucia inlet of the lake, continuous areas of *Chara* of enormous extent, yet for the most part the plants appear in much smaller patches scat-

tered widely over the irregular shallow shore line of the lake. Oil is relatively very cheap in the Canal Zone; facilities for its transportation are excellent; it is effective against all the aquatic stages of the mosquito, both annoying and harmful; it is relatively long-lasting in its effectiveness, requiring fewer applications; the apparatus for the application of oil is inexpensive and simple to operate; oil can be applied with precision over small or discontinuous areas. The airplane's advantage here is limited to the control of *Anopheles* only, in large bogs or marshes of continuous area in which progress on foot or by boat is greatly impeded.

It does seem perfectly evident that the Zone government should continue and even, when conditions permit, extend its present policy regarding the removal from the Zone of the agricultural settlers, who are mostly otherwise unemployed negroes of very limited means, unable to build screened homes on their small holdings. To permit any increase in the number of such settlers is only to add fuel to the fire, and already steps have been taken to prevent the entrance of additional settlers and to reduce gradually the number of those already established. Unfortunately, even complete depopulation once more of the Zone agricultural areas will not entirely remove the sources of infection near the breeding places of the mosquitoes. In many places the boundary of the Republic of Panama, over which we have no control, approaches closely to the lake's edge. Outside the limit of five miles on either side of the canal prism the Zone's jurisdiction extends only as far as the 100-foot contour about the lake, just $12\frac{1}{2}$ feet above the high water level. Since the completion of the canal the strip of Panama territory about the lake's margin has become pretty heavily populated, the construction of the lake having provided a ready means of communication with hitherto almost inaccessible regions.

It has been suggested that in some sort of

bionomic control of the mosquito or of the plants a solution will be found. A certain species of *Chara* (*C. foetida*) has been said to be inimical to the development of mosquito larvae, but recent investigations indicate that it is of no practical benefit and that the Characeae in tropical and subtropical regions elsewhere favor the development of mosquitoes much as they do here.

One ray of hope does appear, however, for the future, perhaps. The new Madden Dam, now being erected across the upper Chagres River at Alhajuela, will impound in the gorges and valleys above it a huge lake whose chief purpose will be to supply water to the lower Gatun Lake in the dry season and to control floods during the wet season. When this dam is functioning there will be less fluctuation in the level of Gatun Lake and consequently, it is hoped, far less of the *Chara* and bladderwort will be exposed at the surface because of lowered waters late in the dry season. The new lake will have no similar trouble because the seasonal difference in levels in this lake will be more than 100 feet, a range that will not permit the development of the plants at the surface of the water.

The conditions herein described indicate clearly that the Canal Zone, contrary to widespread opinion, and despite the great effort and large sums spent upon it, has not achieved complete mastery of its malaria problem, but that the need for continued study and effort is as unremitting as ever. Furthermore, it is indicated that the excellent screening of the houses of the employes is not merely an expensive luxury, but that at times it is still a vital element in the protection of the health of the community. They also emphasize that, beyond the work of the Government in providing sanitation and screening, there still exists a need for the cooperation of individuals to protect themselves from malaria. The health department considers

it advisable to warn the residents of even the most protected communities against needless exposure out of doors after nightfall during the period that the mosquitoes are most active. Unfortunately, the comparative security of the greater part of the year, and the fact that the malaria incidence follows only some weeks after the onset of the flights, tend to make the public generally indifferent to warnings that are issued each year through the local press and by means of circulars.

SUMMARY

Gatun Lake of the Panama Canal system has developed an aquatic flora of *Chara* and bladderwort that provides breeding places for great numbers of *Anopheles*. *A. albimanus* is more domestic and more anthropophilous, and breeds more profusely in the lake in exposed patches of *Chara*. *A. albitarsis* is not anthropophilous and prefers exposed *Utricularia* as a breeding place.

Sanitized areas of the Canal Zone are visited annually, before the onset of the rains of the wet seasons, by flights of *Anopheles* that have flown as much as twelve miles or more from distant lake areas. A sharp rise in the malaria rate occurs following the flight season. Both flight season and peak of malaria are of comparatively brief duration.

Because of the great size of Gatun Lake and the extent and number of breeding places during seasons of low water no economical method of control has been devised. It is believed that future control of Gatun Lake levels within smaller ranges of fluctuation, by means of a new storage lake now being created in the upper Chagres River valley, may, to some degree, lessen the appearance of vegetation at the surface of Gatun Lake and, consequently, the production of *Anopheles*.

The presence of agricultural settlers in the Canal Zone aggravates the situation by furnish-

ing "seed-beds" of infection for the *Anopheles*. Further depopulation of the Zone agricultural area is recommended. The Canal Zone has not completely mastered its malaria problem, and screening of homes is still necessary.

REFERENCE

Robinson, Chas. Budd: The Charga of North America. Bull. N. Y. Bot. Garden, vol. 4, No. 13, June, 1906.

DISCUSSION (Abstract)

Dr. Herbert C. Clark, Panama, R. P.—The construction period of the Panama Canal and the period of operation and maintenance represent different phases in regard to exposures to malaria and the practice of anopheline control measures. During the construction period, the Canal Zone was practically uninhabited and the contact villages on the border were very few and small. The Canal Zone employes occupied a string of villages and labor camps along the line of the Panama Railroad. These were under a short radius control of mosquito breeding and the official quarters were all screened. During this period of time, there was very little opportunity for outdoor entertainment following the day's work. Practically all entertainment was conducted inside the screened homes or the screened club houses. There were no large water surfaces such as the Miraflores and Gatun Lakes now provide.

The period of operation and maintenance was accompanied by the formation of the two lakes mentioned and by the abandonment of many of the railroad towns and camps due to the reduction of the labor force and the concentration of the permanent personnel in the terminal cities and at the lock sites. Very soon, also, an Act was passed that threw open to settlers almost the entire limits of the Canal Zone. This led to the clearing of the major part of the Zone and its occupation by farmers who could not be included in the sanitated areas. At the same time settlements began to grow in number and size at many favorable points on the border of the Zone and lakes. The shore line of Miraflores Lake is short enough and close enough to two lock sites to fall within financial reason in the application of mosquito breeding control and it has been well protected. Gatun Lake is a different problem. It contains 155 square miles of surface and has a changing surface elevation that varies about six feet between flood season and dry season levels. This gives a shore line that varies with the seasons from about 1,000 to 1,200 miles. The new breeding areas are in the many large indentations formed

about this shore line where certain aquatic plants thrive. The rural population in and near these shore lines is in constant business contact with the terminal cities and the population is increasing. The size and permanent character of this "human seed-bed" of malaria is of vital importance in the consideration of any new control measure. Monthly surveys show an annual average parasite index of about 25 per cent.

It seems to me that changes in the anopheline life and aquatic plant life are to be expected. The external surface and alimentary tracts of aquatic migratory bird life and such land animals with aquatic habits as the tapir can transplant seeds that may find a favorable foothold. The external surfaces of migratory birds might also bring in the mosquito egg mats that would thrive. One should also bear in mind introductions by ships making the transit of the Canal as well as the danger to the ships' crews and passengers from our late dry season anopheline flight. The latter risk seems comparatively small, since the personnel on Barro Colorado Island has not observed this flight nor suffered any attacks from malaria that originated on the island.

LePrince suspected in 1913 that the lake shore would be a potential source of trouble. He determined at that time that *A. albimanus* was capable of coming into Gatun from outside the sanitized areas and that they made flights of at least a mile under certain conditions. He noted that some flights were at elevations of 30 and 40 feet and that the important evening flight was at 6:30 to 7:00 p. m., while a return flight at 6:00 a. m. was also noted in which some of the mosquitoes contained blood. He and Bath² believed that the amount of body scent determined the flight direction of *A. albimanus*. It would seem from the return flights noted by LePrince and from the simultaneous Atlantic and Pacific flights mentioned by Dr. Curry's paper that they do not always fly with the air current. Is there a haphazard radial flight in all directions from such breeding grounds or is flight density determined by populated centers and squatter lines of settlements regardless of the direction of air currents?

Our increased rate of hospital and dispensary malaria cases cannot alone be due to these new lake breeding places. We now have good roads, airways and sailing services that take us out of the sanitized zones over the week-ends and holidays. These lead to many exposures that could not have occurred in the construction period of the Canal history. There are far more opportunities for entertainment outside screened quarters during anopheline flight hours than formerly existed. I think we are all agreed that these large lake breeding areas with the possibility of long range flight are of comparatively short duration near

the end of the dry season. It presents, nevertheless, a serious problem in connection with the unprotected inhabitants that live in and near the Canal Zone. It is hoped that the Madden Dam Lake will solve this problem without, also, introducing some new hazard.

Circumstances indicate that *A. albitarsis*, *A. strodeii* and *A. bachmanni* are not important vectors of malaria. It would be interesting, nevertheless, to conduct some biting experiments with these mosquitoes. *A. albimanus* seems capable of meeting any new conditions that have confronted it in this region and I shall not be greatly surprised if Dr. Curry and Mr. Komp are able to prove in observations conducted over a few more dry seasons that flights of twelve to fifteen miles are being made under special conditions by *A. albimanus*.

Dr. W. V. King, Orlando, Fla.—In temperate regions, large migrations of insects are brought about by seasonal changes in temperature, and with many species extensive dispersal regularly occurs in the fall and spring. Other factors such as winds, or scarcity of food, are also responsible for concerted movements of insects. In the case of salt marsh mosquitoes the long flights are probably stimulated primarily by the desire for blood, but it is also possible that the mere presence of great hordes of individuals in close proximity also acts to a certain extent as a flight stimulus. On first reading of the data presented by Dr. Curry it would appear that the flights of *Anopheles albimanus* from Gatun Lake were similar in origin to those of *Aedes sollicitans*; that is, simply a phenomenon of enormous production. I am, however, impressed by the author's statement that the flights occur only during the warm, humid days of the intermediate period between the dry and the wet season, and it seems likely, therefore, that the migrations actually correspond to a seasonal movement, with a change in humidity providing the impetus. Whether or no this is the correct interpretation should, I believe, be given further consideration, as it is a point of general entomological interest.

Regarding the distance of flight, the author appears to be somewhat diffident in stating the mileage covered, possibly from a fear of arousing our incredulity. The figure given is "twelve miles or more," but he also states that all parts of the Canal Zone are affected, and from a map of this area that I have consulted, the City of Panama appears to be at least 20 miles from the main part of Gatun Lake. Accepting the minimum figure of 12 miles, however, this undoubtedly constitutes a new flight record for an anopheline species. There are, in fact, very few recorded observations on flights of much more than a mile. Kligler and Mer in Palestine have reported the finding of *A.*

elutus at a distance of 14 kilometers, or about eight and one-half miles, from the nearest breeding place, and *A. maculipennis* has been observed in California at distances up to four miles. These flights were regarded as pre-hibernation movements. I may also mention an observation made by myself in New Orleans in 1915, when large numbers of *Anopheles crucians* came into the city shortly after the occurrence of a severe storm with widespread flooding of the distant marshes. From a familiarity with the surrounding territory I felt sure that the unusual numbers of mosquitoes had not been produced within at least five miles of the center of the city and the probabilities were that most of the individuals had come from much greater distances. The evidence is therefore accumulating that not all species of *Anopheles* are limited to a short flight range and I have little hesitancy in accepting Dr. Curry's conclusions in view of the fact that, with a species of insect which is inclined to haphazard dispersal, the amount of territory covered must bear some mathematical relation to the number produced. The production of *albimanus* in Gatun Lake under the conditions described is certainly sufficient to account for the extensive distribution. We shall await with interest the publication of more detailed records concerning the flights.